APPROACH FOR IMPROVED STABILITY AND PERFORMANCE OF SOFC METALLIC INTERCONNECTS

PRIORITY

This invention claims priority from a provisional patent application No. 61/023,291 entitled Novel Approach for Improved Stability and Performance of SOFC Metallic Interconnects filed Jan. 24, 2008, the contents of which are hereby incorporated by reference in their entirety.

STATEMENT AS TO RIGHTS TO INVENTIONS MADE UNDER FEDERALLY-SPONSORED RESEARCH AND DEVELOPMENT

This invention was made with Government support under Contract DE-AC0576RLO1830 awarded by the U.S. Department of Energy. The Government has certain rights in the invention.

BACKGROUND OF THE INVENTION

To improve their surface stability and performance, metallic interconnects (aka bipolar plates) in SOFC stacks are often fabricated with a cathode-side conductive oxide protection layer or coating. This electrically conductive oxide layer exhibits some degree of oxygen ion conduction, which allows some oxygen penetration through the protection layer, leading to oxide scale growth at the interface between the protection layer and metallic substrate. If the resulting scale/metal interface is structurally weak, spallation, peeling, or delamination can occur along the scale/metal interface. This can lead to degradation of interconnect performance and reduction of useful stack life. Scale adhesion can be improved by adding oxygen active elements to the alloy during alloy fabrication or by surface treatment of alloys with the oxygen active elements after alloy fabrication, but both of these approaches add cost. Furthermore, reactive element surface treatment may create an extra layer that can negatively affect the surface stability due to the difficulty to sintering protection layers onto the reactive oxide layer.

The present invention includes an assembly approach that includes integrating the protection layer (coating) fabrication and reactive element treatment into a single processing step. That eliminates or at least diminishes many of the problems associated with the prior art and provides new and novel advantages and features.

Additional advantages and novel features of the present invention will be set forth as follows and will be readily apparent from the descriptions and demonstrations set forth herein. Accordingly, the following descriptions of the present invention should be seen as illustrative of the invention and not as limiting in any way.

SUMMARY

The present invention provides a material and a method for its creation and use wherein a reactive element, preferably a rare earth element such as Ce, is included in an oxide coating material. The inclusion of this reactive material modifies the growth and structure of the scale beneath the coating on the metal substrate and improves the scale adherence to the metal substrate. Including this reactive element not only simplifies the surface treatment process which reduces cost, but also simplifies the interconnect structure by eliminating the extra layer and unwanted interfaces caused by reactive element surface treatment. As a result, the surface stability and performance of the interconnect are improved. This also enables the combination of two separate surface engineering processes into one, simplifying the manufacturing process and reducing processing costs, while providing a significantly improved surface engineering quality and stability as well as higher performance of these metallic interconnects compared to those of the traditional prior art processes.

In one embodiment of the invention, a coating for fuel cell interconnect systems having spinel layers of $Mn_{1.5}Co_{1.5}O_4$ with a rare earth element additive is described. (The Mn:Co ratio need not be 1:1, but may be variously configured according to the needs and necessities of the user.) While this material is provided in the example it is to be distinctly understood that the invention is not limited thereto but may be alternatively embodied to include a variety of other compositions including but not limited to Mn—Co—Fe, Mn—Co—Cu, and Mn—Co—Zn oxide and other types of coatings. While in one exemplary embodiment this rare earth element is Ce it is to be distinctly understood that this invention is not limited thereto but may be variously alternatively embodied and configured according to the needs and necessities of a user. Thus, yttrium and any of the rare earth elements (e.g., lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, etc.) either alone or in combination—may be incorporated in varying amounts into these oxide coatings. Preferably the amount of rare earth element that is included in the coating is between 0.01-5%, with some embodiments having between 1 and 5%. (Note that these percentages are calculated on a "metals basis," that is, oxygen is not included in the calculation.) However, it is to be distinctly understood that the exact quantities and amounts may be variously altered and reconfigured according to the needs and necessities of the user.

In another embodiment of the invention a method for creating alloy-based interconnects with improved scale adhesion surface stability is described. This method includes the steps of applying a rare earth-containing coating on ferritic stainless steel utilizing a slurry that contains rare earth element-containing oxide powder.

The purpose of the foregoing abstract is to enable the United States Patent and Trademark Office and the public generally, especially the scientists, engineers, and practitioners in the art who are not familiar with patent or legal terms or phraseology, to determine quickly from a cursory inspection the nature and essence of the technical disclosure of the application. The abstract is neither intended to define the invention of the application, which is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

Various advantages and novel features of the present invention are described herein and will become further readily apparent to those skilled in this art from the following detailed description. As will be realized, the invention is capable of modification in various respects without departing from the invention. Accordingly, the drawings and description of the preferred embodiment set forth hereafter are to be regarded as illustrative in nature, and not as restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**(*a*) shows an SEM micrograph of a prior art material.

FIG. **1**(*b*) shows a SEM micrograph of one embodiment of the present invention.